Gapless Superfluidity

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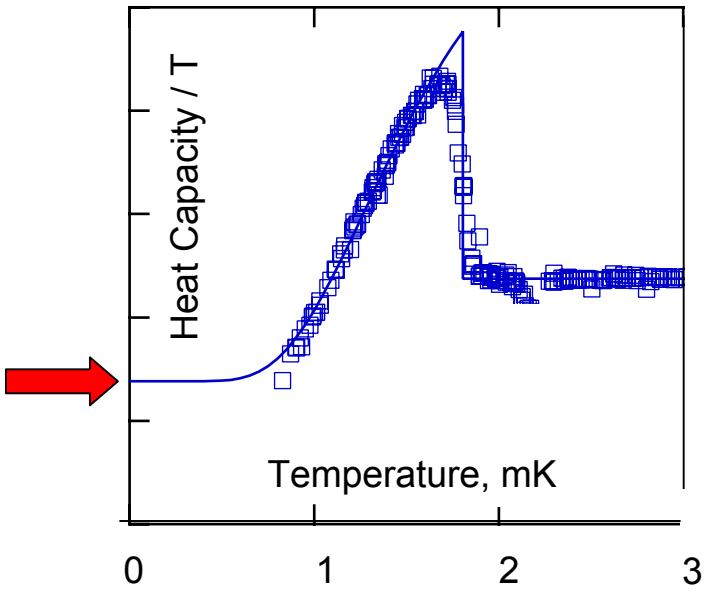
Superfluids and superconductors have fascinating behavior with great promise for applications. They have an energy barrier, or energy gap, that preserves their "super" properties. Disorder from impurities can destroy the superfluid and destroy the gap. In superfluid ^{3}He we have learned to control disorder using an extremely porous aerogel glass. But then we discovered that the superfluid becomes gapless (red arrow) meaning that impurities destroy the gap before they destroy superfluidity. Such disorder is unavoidable in many superconducting materials and now can be understood by study of superfluid ^{3}He.



The non-zero intercept at T= 0 (red arrow) is *required* if our data is to satisfy the third law of thermodynamics; this indicates gapless superfluidity.

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Education:

Undergraduate Cy Hendrickson has contributed to this work in developing new heat exchanger materials to improve thermometry techniques at ultra-low temperatures. He is shown at the left measuring the effectiveness of the heat exchanger by analysis of the adsorption of gas at cryogenic temperatures. Undergraduate Ned Calder, Goldwater awardee, helped in the initial phases of the research. He is now working on Gravity Probe B at the Jet Propulsion Laboratory. Current graduate students Hyoungsoon Choi and John Davis are continuing work on this project.

Outreach:

Cy Hendrickson, an undergraduate student in the Northwestern University Integrated Science Program, along with adviser William Halperin building melting curve thermometers. The ISP emphasizes undergraduate research involvement. Halperin has been the director of the ISP program for five years.